# Influence of the Urea in the Colour Intensity on Digital Printing

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**Abstract**

It was studied the influence of urea in the digital printing of cotton in yellow, red and blue colours. In the first tests, the amount used were in the preparation recipes was 0 (without), 50 and 100 $g{\cdot}L^{-1}$, demonstrating high influence in medium (60 %) and dark shades (90 %), in the all three colors assessed. Therefore, another test was performed in order to verify the minimum possible amount to be used, without detriment in the colour intensity ($K{\cdot}S^{-1}$), concluding that the quantities above 80 g·L-1 does not influence in a significant increase in the $K{\cdot}S^{-1}$.

***Keywords:*** *urea, colour intensity, digital printing*

## 1. Introduction

The textile printing, a millenary art, is a coloring process in which just one side of the fabric is colored. It can be defined as a number of pictures, or drawings, united in order to construct a design. About 20 % of all textile products are printed and 45 % to 50 % of these ones are printed with pigments, the easiest and cheapest printing process. However, the pigment process provides a touch less smooth than the dyestuff printing process (ANDREAUS et al, 2010; BEZERRA et al, 2014).

Even with the scanning of drawings in the 1980's, the recording of analogical matrices do not expanded the possibilities in terms of expression. Meanwhile, with the appearing of digital printing in the 2000's, several limitations have disappeared because of a fully digital process (NEIRA, 2012).

Until recently, the digital printing for was limited to the creation of samples, or small samples that anteceded the printing of another conventional process in large scale, rotary printing process as example. Technological advances, however, have created the potential for printing digital in order to replace the traditional printing in short and medium length, and even in some amount of high-quality production (MACEDO, 2008). Nowadays, the digital printing is gaining more space. According to Valdir Siani Moura, Industrial Manager of Salete Dyeing and Printing, one of the biggest printing in Sao Paulo, 40 % of their production are digital and 10 % of this production is performed in cotton. Prado (2013) also described that in 2012, the tissues composed of cellulose fibers were the most produced, when compared to other fibers in the same period.

Based on these facts, was chosen to work with cotton tissue, in digital prints produced with reactive dyestuff, which are currently the most dyestuff used in Brazil (ABIQUIM, 2014).

### *1.1. Urea*

Of diaminomethanal scientific name, is also known as carbamide or urea and has molar mass of 60.0 g·mol$^{-1}$. The molecular structure is represented in Figure 1.

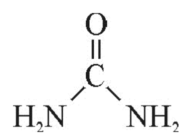

**Fig. 1.** Diaminomethanal structure

It is widely employed in industry of agglomerated for furniture, such as resin urea formaldehyde, and also in the sector of fruit and vegetable as a source of nitrogen in fertilizers (IWAKIRI et al, 2012; WERNECK et al, 2012). It has the property of increasing the solubility of several reactive dyestuffs and also acts as a hygroscopic agent. Besides being responsible for adding moisture to the printed area during vaporization, also works in diffusion of dyestuff into the fiber, favoring the reaction dyestuff/cellulose (LOPES, 2009).

It is a substance that increases the concentration of nitrogen in the effluent, which can cause eutrophication of aquatic system because their properties as nutrient, favoring the excessive growth of microorganisms (BASTIAN and ROCCO, 2009; COSTA, 2010). To minimize the environmental impact and auxiliary in the effluent treatment, becomes important to reduce the amount of urea in the process of printing, one of the factors that contributed to the development of this study.

## 2. Experimental

Equipments: Mathis M Mixer, Spectrophotometer VIS Konica-Minolta CM-3600d, Mathis GD-B Steamer; Brookfield Analogical Viscometer Model LVT, Foulard Mathis, Suzuki Washer Machine with peripheral speed of 40 m·min$^{-1}$, three fins 5 cm high and 17 s as time cycle, Digital Printer Stork Prints SPG Print ruby V-II.

Reagents: anionic leveling agent, anionic synthetic thickener, urea 98 % and sodium carbonate 95% to prepare the preparation paste; anionic leveling agent and anionic retardant agent for the washing off.

### *2.1. Pastes preparation, padding and drying*

The preparation pastes recipes are described in Table 1. With the exception of urea, amounts of chemical were suggested by the auxiliaries' manufacturer. All pastes were mixed at 1500 RPM during 30 minutes; then the viscosity of the three pastes was measured; the samples were padded with pick-up 90 % and, after padding, the samples were dried at 120 °C for 10 minutes, with circulating air in 1500 rpm.

**Table 1.** Preparation recipes

| Chemicals | Quantities | | | Viscosity (cP) |
|---|---|---|---|---|
| Urea (g·L$^{-1}$) | 0 | 50 | 100 | 800 à 26 ºC |
| Thickenner (g·L$^{-1}$) | 50 | 50 | 50 | |
| Levelling agent (g·L$^{-1}$) | 150 | 150 | 150 | |
| Sodium carbonate (g·L$^{-1}$) | 20 | 20 | 20 | |

*2.2. Printing*

Was printed the three colours with intensities of 30 %, 60 % and 90 %. After printed, the samples were vaporized at 105 °C during 10 minutes, with 80% of moisture and air circulation in 1200 RPM.

*2.3. Washing off*

The samples were washed in a liquor ratio of 1:10, with the recipes described in Table 2 and the process in the Figure 2.

**Table 2.** Washing off recipes

| Step | Chemical |
|---|---|
| A | 0.50 $g\cdot L^{-1}$ de retardant agent |
| B | 0.25 $g\cdot L^{-1}$ de retardant agent |
| C | 0.50 $g\cdot L^{-1}$ de levelling agent |
| D | 0.25 $g\cdot L^{-1}$ de levelling agent |

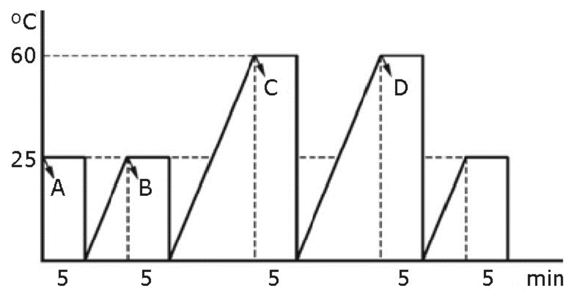


**Fig. 2.** Washing off procedure

*2.4. Colour assessment*

Adopting the light shades to values of 30 %, medium shades to values of 60 % and dark shades to values of 90 %, were assessed the values of reflectance (R) in CIELab System, under illuminant D65 10º, calculating the colour intensity ($K\cdot S^{-1}$) by Kubelka-Munk equation (SILVA et al, 2012).

$$K\cdot S^{-1} = (1-R)^2\cdot(2R)^{-1} \quad (1)$$

## 3. Results and discussion

The values of colour intensity are described in Table 3 (yellow), Table 4 (red) and Table 5 (blue). These values were measured with the "not printed parties" adopted as "zero point". The data were ploted in the Grafic 1 (yellow), Grafic 2 (red) and Grafic 3 (blue).

**Table 3.** $K\cdot S^{-1}$ yellow values

| Dyestuff ($K\cdot S^{-1}$) | Urea ($g\ L^{-1}$) | 30 % | 60 % | 90 % |
|---|---|---|---|---|
| Yellow | 0.00 | 0.4843 | 2.0478 | 13.0850 |
| | 50.00 | 0.7075 | 2.9730 | 16.8010 |
| | 100.00 | 2.4834 | 7.1947 | 21.0650 |

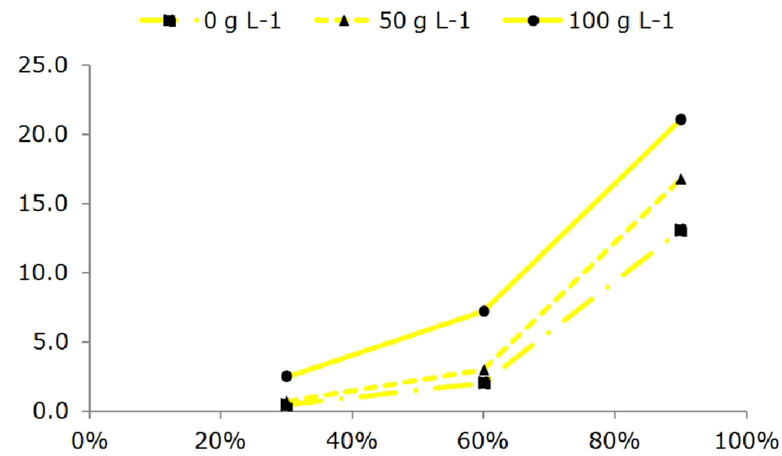


**Fig. 3.** Yellow values

In the light shades (30 %) was observed that the amount of urea does not make too much significance in the values of $K{\cdot}S^{-1}$. The differences are more significant in the medium and dark shades (60 % and 90 %). The $K{\cdot}S^{-1}$ value obtained with 100 $g{\cdot}L^{-1}$ of urea was 1.25 times higher than the value of $K{\cdot}S^{-1}$ obtained with 50 $g{\cdot}L^{-1}$ and 1.61 times higher than the value obtained without urea.

**Table 4.** $K{\cdot}S^{-1}$ red values

| Dyestuff ($K{\cdot}S^{-1}$) | Urea ($g\ L^{-1}$) | 30 % | 60 % | 90 % |
|---|---|---|---|---|
| | 0.00 | 0.2443 | 0.9552 | 4.2336 |
| Red | 50.00 | 0.3785 | 1.4796 | 5.8427 |
| | 100.00 | 0.6891 | 2.6580 | 10.9200 |

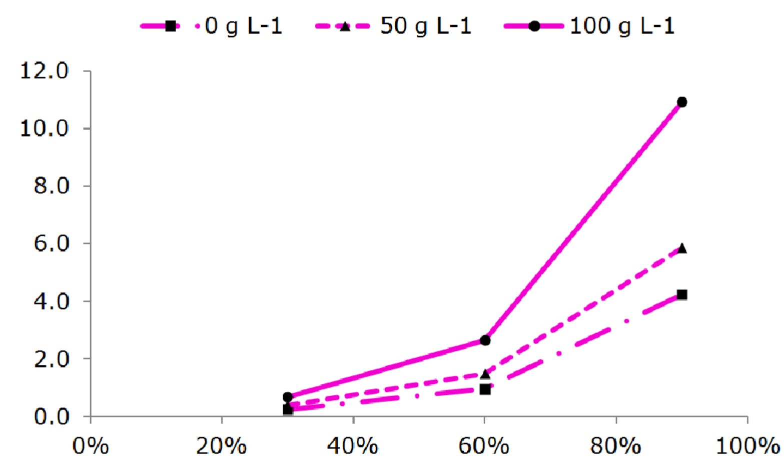


**Fig. 4.** Red values

As the same as in the yellow colour behaviour, in the red light shades (30 %) was observed that the amount of urea does not make too much significance in the values of $K{\cdot}S^{-1}$. However, the difference in the dark shades (90 %) obtained with 100 $g{\cdot}L^{-1}$ of urea, were 1.86 times higher than the value obtained with 50 $g{\cdot}L^{-1}$, and 2.58 times higher than the values obtained without urea.

**Table 5.** $K \cdot S^{-1}$ blue values

| Dyestuff ($K \cdot S^{-1}$) | Urea ($g\ L^{-1}$) | 30 % | 60 % | 90 % |
|---|---|---|---|---|
| | 0.00 | 0.1624 | 0.5200 | 3.2299 |
| Blue | 50.00 | 0.2647 | 1.0522 | 7.1175 |
| | 100.00 | 0.5511 | 1.9712 | 13.7330 |

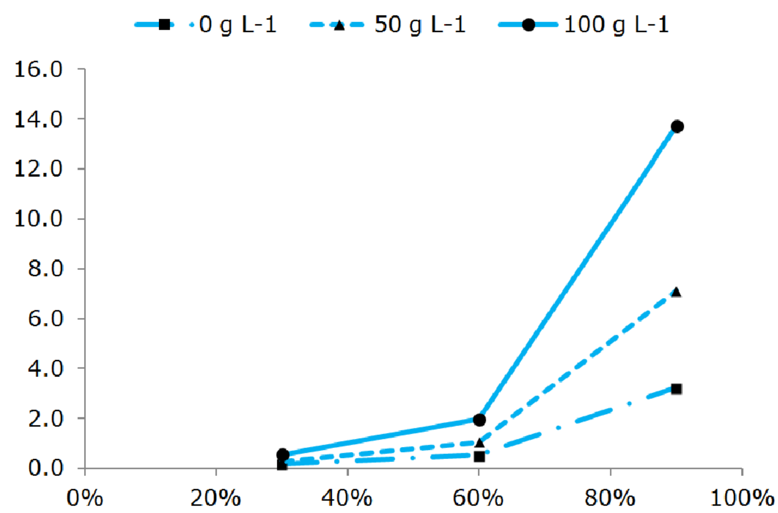


**Fig. 5.** Blue values

Again, as the same as in the yellow and red colours behaviour, in the blue light shades (30 %) was observed that the amount of urea does not make difference in the values of $K \cdot S^{-1}$. In the medium shades, the blue behavior seemed as the red one. However, the difference in the dark shades (90 %) obtained with 100 $g \cdot L^{-1}$ of urea, were 4.25 times higher than the value obtained without urea.

Based in the previous results, in which was observed that the amount of urea is significant in the $K \cdot S^{-1}$ values, another test was performed in order to determinate the optimized amount of urea. At this time, the urea quantities used were 80 $g \cdot L^{-1}$, 100 $g \cdot L^{-1}$ an 120 $g \cdot L^{-1}$, at same conditions as used before. The results are describes in the Table 6 and the data in the Grafic 6.

**Table 6.** Yellow, red and blue $K \cdot S^{-1}$ values

| Dyestuff ($K \cdot S^{-1}$) | Urea ($g \cdot L^{-1}$) | | |
|---|---|---|---|
| | 80 | 100 | 120 |
| Yellow | 20.16 | 19.63 | 19.55 |
| Red | 10.45 | 9.93 | 11.24 |
| Blue | 12.94 | 12.72 | 12.34 |

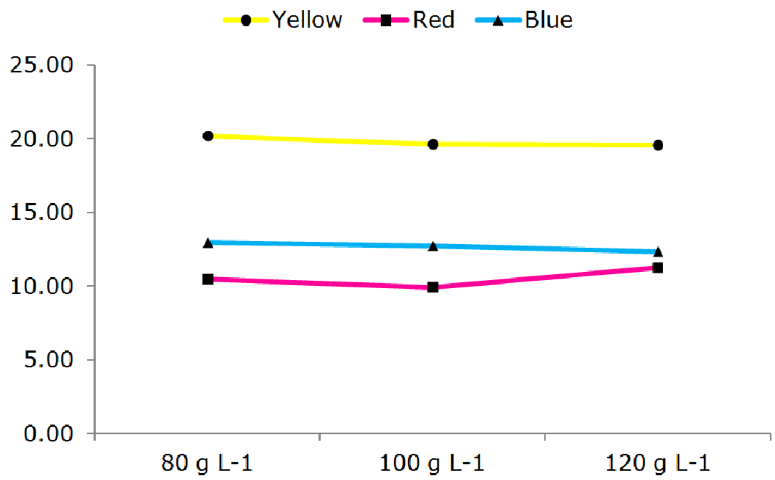


**Fig. 6.** Data of the three dyestuff

The values of $K{\cdot}S^{-1}$ obtained with the three amount of urea do not presented significance in the tested samples.

## 4. Conclusions

In the first step of this research, was observed that the urea quantity can hardly interfere in the medium and dark shades, in the three tested dyestuff. The same behavior was not observed in the light shades.

In the second step was concluded that urea concentrations above 80 $g{\cdot}L^{-1}$ did not interfere in the values of $K{\cdot}S^{-1}$ in the three tested dyestuff. Therefore, based in the results obtained, it can concluded that 80 $g{\cdot}L^{-1}$ of urea is the necessary amount. Smaller amount of urea produce smaller amount of nitrogen, amount that will be avoid in the final effluent.

**Acknowledgment**

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